EXPRESS MAIL EI 076028701US

IMPROVED PRINTING MACHINE

FIELD

The present invention relates to rotary printing machines, and more particularly, to rotary printing machines in which individual sheets are conveyed through the machine by vacuum-type conveyor means.

BACKGROUND

In the rotary printing art, it is known to transport individual sheets of material through the printing machine by the use of driven belts, or driven rollers, which also employ a partial vacuum. Examples of such printing machines are disclosed in US Patents 5,564,693 and 5,782,183. However, all of such prior printing machines require large motors and blowers, and high levels of power to drive the motors. These are required in order to create the necessary partial vacuum, or subatmospheric pressure, which is required in order to force the blanks against the belts or powered rollers. In addition, prior belt and roller transport systems have been designed to deliberately partition and divide the length of the printing machine into individual and multiple segments or zones with each zone being separated from the next zone by partitions as also illustrated, for example, in the above indicated patents. Such systems produce highly unequal subatmospheric pressures in the various zones. This requires that each stage of the machine be provided with an over-sized motor and blower unit in order to be certain that each zone will have

the minimum required pressure differential for maintaining the sheets in firm contact with the transport belts or rollers.

In addition it has been discovered that, while conveyor belts are more efficient and allow less slippage than powered rollers, the most efficient and effective transport system results from the use of conveyor belts for moving the sheets, and non-powered guide rollers, or non-rotating curved supports, for guiding the sheets into and out of each stage.

SUMMARY

The present invention provides a rotary printing machine of multiple stages in which a single, extended, non-partitioned and continuous zone of subatmospheric pressure is maintained on one side of the board line throughout the multiple stages. The present invention also provides a transport system which comprises a plurality of powered conveyor belts and a plurality of non-powered, guide rollers or non-rotating supports having curved surfaces engaging the sheets.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side elevational view of one preferred embodiment of the present invention;

FIG. 1a is an enlargement of a portion of the feed inlet end of FIG. 1;

FIG. 2 is a schematic side elevational view of a second preferred embodiment;

FIG 3. is a fragmentary side view of the housings of two stages of the machine with a fluid seal therebetween;

FIG. 4 is a perspective view of the bottom side of the conveyor belts in the embodiment utilizing rollers with the belts;

FIG. 5 is a perspective view of the top side of the FIG. 4 embodiment;

FIG. 6 is a side elevational view, partly in cross-section, of the FIG. 4 - 5 embodiment;

FIG. 7 is a perspective view of the top side of the belts in the embodiment utilizing non-rotating curved supports;

FIG. 8 is a perspective view of the bottom side of the FIG. 7 embodiment;

FIG. 9 is a side elevational view, partly in cross-section, of the FIG. 7 - 8 embodiment; and

FIG. 10 is a perspective view of two forms of non-rotating supports.

DETAILED DESCRIPTION

Referring to FIG. 1, an example of a flexographic printing machine 10 is shown as comprising a feed or inlet stage 12, three stages of printing 14, 16 and 18, a die cutter stage 20 and an optional pin stripper 22. Of course, it will be readily understood to those skilled in the art that the number of printing stages may vary from one machine to another, and that additional stages may be added, such as a folder-gluing stage, or the printing machine may comprise only one or more printing stages depending upon the needs of the customer. For purposes of schematic illustration, "boards" or sheets 24 of material to be imprinted are illustrated as passing through the printing machine from feed rollers 26 to discharge rollers 28; the horizontal plane of the moving sheets being known as the "board line". In the preferred embodiment, sheets 24 are composed of corrugated cardboard, hereinafter "corrugated" as known in the industry,

such as to form containers or displays after multi-color printing, of very high resolution.

As is conventional, each printing stage includes a print cylinder 30 and an impression cylinder 32 between which the sheets pass while being imprinted with a different color of printing. In order to convey each sheet to the next stage, the present invention provides a unique combination of driven conveyor belts 34 and guide supports 36. An "extended" or "continuous" partial vacuum in an elongated and unitary chamber 40 is provided above horizontally extending plates 50. The plates are positioned slightly above the board line, thus creating slots 35 for air flow around the impression cylinders 32. Preferably, it has been discovered that the bottom surfaces of plates 50 should be in the order of 1/16 to 3/16 inch above the board line, and more preferably, in the order 1/8 inch. Also, it has been discovered that the horizontal width of slots 35 should be in the order of 1/16 to 3/16 inches, and most preferably in the order of 1/8 inch. As shown in FIGS. 1 and 2, the horizontal ends of extended chamber 40 are sealed by end closures 55 and 57.

A plurality of fans or blowers 42 driven by motors 43 are provided to exhaust air from the extended and elongated chamber

40 thereby producing a continuous partial vacuum in extended chamber 40 above plates 50. Since atmospheric pressure exists below the plates, sheets 24 are forcefully urged upwardly and pressed against the lower reaches of belts 34 in firm frictional contact with the belts. As a result, the sheets are transported from stage to stage without slippage or becoming skewed.

With regard to extended or continuous vacuum chamber 40, it will be noted that this continuous and unitary chamber extends throughout the length of the printing stages and that it is not sectioned or partitioned between the printing stages as in prior vacuum conveyor systems. As a result, it has been discovered that, instead of partitioning each stage around each fan or blower, it is substantially more effective and efficient to eliminate all structural barriers throughout the length of the elongated chamber. Thus, it has been discovered that an essentially constant and uniform subatmospheric pressure can be created in all portions of elongated chamber 40. This makes the pressure differential above and below the sheets virtually uniform whether a sheet is directly under a blower 42 or is passing from one stage to the next under slots 35 on either side of an associated impression cylinder 32. This was not previously possible since wide variations occurred in the pressure differentials along the length of the machine. In addition, the partial vacuum pressure above the sheets throughout the stages

may be made only in the range of 1 - 3 inches of water, and this substantially reduces the size and power requirement for the motors.

Of course, the forgoing description of the invention is not limited to three printing stages, or to short transfer sections. As shown in FIG. 2, a printing machine having less printing stages, and a substantially longer transfer section to the next stage, such as a die cutter stage, may also be provided with the substantial benefits of the present invention.

As schematically illustrated in FIG. 2, the same elements have the same numerals, and it has been discovered that, as in the FIG. 1 embodiment, the subatmospheric pressure in extended chamber 40 may be made substantially constant, such as in the order of ± 0.5 inches of water, over the entire length of the machine from print stage 14 to die cutter stage 20. This remains true even if it includes a substantially elongated transfer section 17 located between the last printing stage 16 and the die cutter stage 20. Thus, it is to be understood that it has been discovered that the entire elongated and extended chamber 40 should be made without partitions as in the prior art, and that the partial vacuum throughout chamber 40 may be maintained substantially more constant and uniform than previously possible.

FIG. 3 schematically illustrates the housings of two of the stages when they are secured together in operation by conventional locking means not shown. The housing of each stage has side edges 66a and 66b which extend vertically and abut each other. These vertical side edges are composed of relatively thick metal, such as cast iron, which may be machined so as to engage each other in a substantially airtight manner so as to significantly restrict the entry of ambient air. However, the upper portions 70 of the stages are formed of sheet metal which cannot be machined so as to significantly preclude the entry of air into the machine. The present invention solves this problem by providing flanges 72, and gaskets or seals 74 which extend across the upper width of the stages, and downwardly a few inches between flanges 72. In this manner, the upper portion 40 of the machine, which is above the board line as defined by plates 50, is well sealed against entry of ambient air. As a result, blowers 42 of reduced size may create the desired degree of subatmospheric pressure with a reduced size of motors 78 and a substantially reduced amount of horsepower during operation by the customer.

Referring to FIGS. 4 to 6, each of plates 50 are provided with a plurality of apertures or slots 51 through which the lower reaches of a plurality of conveyor belts 34 extend downwardly and horizontally into frictional engagement with sheets 24. Conveyor

belts 34 are driven in unison, by conventional drive means not shown, and the bottom reaches of the belts transport the sheets from stage to stage. However, in addition to conveyor belts 34, the transfer system includes a plurality of idler rollers or non-rotating supports, as previously described, which engage the leading and trailing edges of the sheets. In the embodiment of FIGS. 4, 5 and 6, idler rollers indicated generically by numeral 56 are provided as shown in cross-section in FIG. 6. These rollers extend slightly below the plane of plates 50 such as through apertures 60. Rollers 56 are provided in sets of two pairs, shown on the right and left ends of plate 50 in FIG. 6, so as to engage the leading and trailing edges of the sheets, respectively. Referring to the lead roller pair shown on the right in FIG. 6, this pair includes a first roller 56' and a second roller 56". First roller 56' is positioned so as to engage and depress sheet 24 downwardly away from engagement with plate 50 and out of contact with belt 34 at the curved portion of the belt moving around pulley 58. This is because it has been discovered that the outer surfaces of the conveyor belts travel at higher linear speeds as they pass around the pulleys than the speeds of the flat belt portions between the pulleys, and this has led to serious registration problems in the prior art.

The sheets are further maintained out of contact with plates 50 and belts 34 by trailing rollers 56". The axes of these

rollers are preferably located vertically below the axes of pulleys 58 or slightly to the left, as viewed in FIG. 6, beyond the flat but still stretched portions of the belts. Therefore, the sheets do not engage any stretched portions of the belts, and only engage the flat, non-stretched portions of the belts which are of uniform linear speeds. In addition, as shown in FIGS. 4 and 5, additional rollers 57 are positioned laterally between the pairs of rollers where there is insufficient room on plates 50 to accommodate pairs of rollers.

Referring to the right-hand portion of FIG. 6, it will be noted that the edge portion 62 of plate 50, which is the leading edge of the plate for receiving each sheet, is angled upwardly from the horizontal by an acute angle in the order of 10 to 20°. As a result, any sheet which may have a warped leading edge is received and guided by edge portion 62 so as to pass smoothly through that stage of the machine and not cause jamming.

As previously indicated, it has been discovered that the rollers may be eliminated and replaced by lower-cost, non-rotating supports, while continuing to obtain the advantages described above. Referring to FIGS. 7 - 10, it will be understood that all of the previously described structure is the same, except that, rollers 56 are replaced by non-rotating, curved supports 70. Curved supports 70 may be molded or stamped out of

metal as shown in FIG. 10 so as to have a spherical surface 72 or a frustro-cylindrical surface 73, or other smoothly curved surface. It will also be understood that flange portions 74 may be connected to the top surfaces of plates 50, as shown in FIG. 7, so that the curved surfaces extend downwardly through apertures 80 in plates 50 as best shown in FIGS. 8 and 9. Non-rotating supports 70 are preferably positioned in pairs as shown in FIG. 9, or in the staggered pattern shown in FIGS. 7 and 8. In either case, supports 70 function to force the sheets downwardly, away from the curved portion of belts 34, in the same manner as described with respect to rollers 56. As a result, the sheets only contact the linear portions of the belts and registration is not adversely effected by contact of the sheets with the curved surfaces of the belts which move at a higher linear speed around the pulleys.

Referring to FIG. 1a, an enlarged view is shown of the plate and non-driven assembly at the front end of the machine in a further preferred embodiment. This assembly is supported by a transverse support 53 which extends laterally across the machine at a right angle to the direction of travel of the sheets. Support 53 carries a relatively short plate 50' upon which non-driven supports 36 are carried as previously described. Because of this unique front end assembly in the preferred embodiment, the sheet being fed from feed rollers 26 is maintained in perfect

alignment with the nip between print cylinder 30 and impression cylinder 32 despite any warpage of the front end of the sheet because of plate 50' and non-driven supports 36 as previously described.

From the foregoing description of several preferred embodiments of the present invention, it will be apparent to those skilled in the art of printing machines that numerous variations may be made. For example, the present invention is equally applicable to printing machines which print on the upper surface of the material instead of below the material to be imprinted as illustrated. In that embodiment, lower chamber 52 is sealed by seals 74 and is maintained at the subatmospheric pressure while chamber 40 is at atmospheric pressure, and rollers 56 or non-rotating supports 70 are positioned above plates 50 instead of therebelow. Accordingly, it is to be understood that the forgoing description of preferred embodiments is intended to be only illustrative of the principles of the invention, rather than exhaustive thereof, and that the true invention is not intended to be limited other than as expressly set forth in the following claims, i~~nterpreted under the Doctrine of Equivalents.~~